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VERIFICATION

I, Karin Klepsch, Hochwaldsteig 7, D-14089 Berlin, hereby declare that I am conversant in the German and the English languages and that I am the translator of the document attached and certify that to the best of my knowledge and belief the following is a true and correct English translation of the document WO 2005/021896.

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Underwater Cleaner

The invention relates to an underwater cleaner, more specifically for a swimming pool, said underwater cleaner having a suction nozzle housing with a suction nozzle communicating with a suction chamber and a suction mouth defining a suction plane, an exhaust channel to which a filter device is connected commencing at said suction chamber, a water jet nozzle through which pressurized water is adapted to be supplied to the suction chamber so as to create a negative pressure in said suction chamber according to the principle of a water jet pump opening out into said suction chamber.

It is known to use swimming pool vacuum cleaners for cleaning swimming pools. Such type devices are for example disclosed in U.S. Patent No. 5,317,776 A, U.S. Patent No. 5,842,243 A, U.S. Patent No. 6,119,293 A or U.S. Patent No. 6,473,927 B1. The disadvantage of these known swimming pool vacuum cleaners is that they are quite unwieldy, need a certain start-up time and/or are complicated to operate.

U.S. Patent No. 5,450,644 A shows a battery-operated submersible cleaner in which a pump draws water through a suction nozzle into a filter. The pump, which is configured to be a radial pump, is disposed between the suction nozzle and the filter. U.S. Patent No. 4,962,559 A describes a cordless swimming pool vacuum cleaner in which a pump draws water through the suction nozzle and a filter back into the swimming pool. The filter is thereby interposed between the suction nozzle and the pump. Such type known cordless underwater cleaners having suction pumps for drawing the water have the disadvantage of suffering from poor suction performance so that they are not capable of sufficiently sucking up heavy mass impurities such as sand, soil, pebbles. On the other side, swimming pool vacuum cleaners offering high suction performance have dimensions that make them unsuitable for cleaning difficult to access areas such as steps or corners of a swimming pool.

A battery-operated swimming pool vacuum cleaner is known from U.S. Patent No. 6,502,269 B1 in which water is drawn together with impurities through a

suction nozzle into a filter according to the principle of the water jet pump. Since the water jet nozzle opens out into the suction chamber quite a large distance apart from the suction nozzle, impurities having a heavier mass are difficult, if at all, to remove. The water jet nozzle is fed by a submersible pump that draws water via a sieve at the highest point of the suction chamber. The disadvantage thereof is that, upon starting the swimming pool vacuum cleaner, the time the submersible pump only delivers air is quite long unless the suction chamber is flooded manually beforehand. In any case, initial start-up is rendered difficult. The minimum depth of utilization is determined by the quite large distance separating the suction port of the submersible pump and the surface to be cleaned. By drawing water from the suction chamber there is a risk that the sieve gets quickly clogged by particles.

Further, a suction nozzle for a swimming pool vacuum cleaner in which dirty water is drawn according to the principle of the water jet or Venturi pump is known from U.S. Patent No. D435,246 S. For this purpose, a water hose of an external source of water pressure can be connected to the suction nozzle. The water flowing through the water jet nozzle into the suction chamber creates a negative pressure in said suction chamber, so that dirty water is drawn via the suction nozzle. The disadvantage thereof is that this suction nozzle as well only permits to remove quite light-weighted, light mass impurities.

A swimming pool cleaner comprising a collecting manifold for collecting incoming pressurized water and having a number of sweep hoses through which dirt is raised branching therefrom is also known from U.S. Patent No. 4,950,393 A. Further, jet nozzles lead from the collecting manifold into the suction chamber of the swimming pool cleaner configured to be a venturi chamber, the jet nozzles being spaced on the circumference of the suction nozzle. According to the water jet principle, water is drawn from the bottom region of the swimming pool and supplied to a filter according to the water jet principle. Since the jet nozzles substantially extend from the suction plane at an angle of about 90°, they are unable to sweep impurities away from the bottom of the swimming pool. This function has to be performed by the sweep hoses. This swimming pool cleaner is complicated, bulky and quite unwieldy to use. Moreover, it needs high water flow rates and, as a result thereof, a pump achieving high delivery.

The document FR 2 667 099 A1 discloses a swimming pool vacuum cleaner in which two water jet nozzles open out tangentially into a suction chamber and generate swirling flow. The water jet nozzles are thereby directed onto the suction plane, with the flow centreline of the water jet nozzles being inclined at an angle of $\leq 0°$ with respect to the suction plane. This makes it possible to remove solid deposits from the bottom of the swimming pool; however, the capacity of the pump relying for operation on the water jet principle is quite low as a result of the unfavourable arrangement in terms of fluid flow. The water jet nozzles raise dirt so that re-contamination of the swimming pool through stray dirt particles is not unlikely. Another disadvantage is that two water jet nozzles are needed, which makes it necessary to provide a pump having quite high capacity.

It is the object of the invention to avoid these drawbacks and to increase in the simplest possible way the cleaning performance of underwater cleaners of the type mentioned herein above. The underwater cleaner is anticipated to be, as far as practicable, of a small construction and wieldy in order to allow for easy cleaning of steps or corners in a swimming pool.

This is achieved, in accordance with the invention, in that the water jet nozzle opens out into the suction chamber in the region of the suction nozzle, with the distance between the water jet nozzle and the suction plane being preferably smaller than the smallest inner width of the exhaust channel and that, in the region where it opens into the suction chamber, a flow centreline of the water jet nozzle is inclined at an angle of $\geq 0°$, preferably of between $>0°$ and $\leq 45°$, with respect to the suction plane, with the distance between the water jet nozzle and the suction plane preferably being a maximum of two thirds of the smallest inner width, preferably maximum half the smallest inner width of the exhaust channel.

It is particularly advantageous if the distance between the water jet nozzle and the suction plane is smaller than half the maximum height of the suction chamber. In practice, it has been found advantageous if the maximum distance between water jet nozzle and suction plane is 7 cm, preferably between 2.5 cm and 3 cm. This makes it possible to also remove small and medium sized pebbles for example.

The important point is that the water jet discharges into the suction chamber in closest possible proximity to the suction plane. As a result, the water is caused to directly flow against the dirt particles which are swept toward the exhaust channel so that dirt particles with a heavier mass, which could not be removed by mere suction, are allowed to be raised from the bottom of the swimming pool and to be supplied to the filter. Accordingly, impurities are removed by the combined action of suction and pressure resulting from the water jet. A particular effect of benefit is obtained if the water jet nozzle opens out into the suction chamber on the side opposite the exhaust channel; there is thereby preferably provided that the water jet nozzle is directed into the exhaust channel, the flow centreline being particularly preferred to be inclined at an angle of less than 180°, preferably of between 150° and 170°, with respect to the axis of the exhaust channel. Particularly high suction performance is achieved if the axis of the exhaust channel is inclined at an angle of between 0° and 45°, preferably of between 10° and 15°, with respect to the suction plane. The inner width of the suction nozzle is preferably slightly smaller than the width of the exhaust channel. This permits achieving high flow velocities in the region of the suction nozzle, said high velocities assisting the cleaning process.

As far as practicable, raising the dirt should be avoided. In order to achieve this while providing good suction and cleaning effect, it is advantageous if the flow centreline of the water jet nozzle is inclined at an angle of preferably $\leq 25°$, most preferably of $\leq 15°$, with respect to the suction plane.

In a particularly simple embodiment of the invention, there is provided that a water hose communicating with an external pressure source is connectable to the water jet nozzle. This however entails the not always desirable side effect that additional water is supplied to the pool with an increase of the water volume in the pool. This side effect can be avoided if the underwater cleaner comprises an integrated, preferably battery-operated submersible pump the pressure socket of which is flow connected to the water jet nozzle. In accordance with a particularly preferred implementation variant, there is provided that the suction port of the submersible pump is disposed outside of the suction chamber, preferably outside of the suction nozzle housing, and is hydraulically separated from the suction chamber. It is particularly advantageous if the suction port is

disposed in the region of the suction plane, the spacing between suction port and suction plane being preferably smaller than the maximum height, most preferably smaller than half the maximum height of the suction chamber. This quite low location of the suction port allows utilizing the underwater cleaner in shallow water as well. Since the submersible pump does not draw water from the suction chamber but from outside the suction room, directly from the swimming pool, instead operating the underwater cleaner is uncomplicated because air-filled spaces on the suction side of the submersible pump are avoided.

In another embodiment of the invention, there is provided that the exhaust channel and the filter device are disposed on the actuation side of the suction nozzle housing, which is turned toward the user. Since the filter device and the exhaust channel are disposed on the actuation side, protrusions obstructing the sight onto dirt on the side opposite the actuation side are avoided so that the user is allowed to guide the underwater cleaner with great accuracy over the dirt to be removed via the actuation rod.

Within the scope of the invention, there is further provided that, on its suction side turned toward the body to be sucked up, the suction nozzle is framed at least partially by the rubber lips or brushes forming the suction mouth. The rubber lips or brushes serve to accommodate irregularities on the bottom of the swimming pool so that full suction is ensured even with swimming pool bottoms comprising dimples, bumps or asperities.

In a battery- or accumulator-operated implementation variant, there is provided that the submersible pump is connected to a battery housing via an electric cable preferably configured to be a spiral channel. In this case, the battery housing may preferably be detachably connected to an actuation rod by a rubber band.

In a particularly compact embodiment of the invention, there is provided that the submersible pump and/or the battery housing are integrated in the suction nozzle housing.

The invention will be discussed in greater detail herein after with reference to the FIGS.

FIG. 1 is a front view of the underwater cleaner of the invention in a first implementation variant;

FIG. 2 shows the underwater cleaner in a sectional view taken along the line II-II in FIG. 1,

FIG. 3 shows the underwater cleaner in a side view pursuant to arrow III in FIG. 1,

FIG. 4 shows the underwater cleaner of the invention in a second implementation variant,

FIG. 5 shows the underwater cleaner in a sectional view taken along the line V-V in FIG. 4,

FIG. 6 shows the underwater cleaner in a sectional view taken along the line VI-VI in FIG. 4,

FIG. 7 is a top view of the underwater cleaner in a third implementation variant,

FIG. 8 is an oblique view of said underwater cleaner, and

FIG. 9 is another oblique view of the underwater cleaner.

Components in the implementation variants having identical functions are identified by the same reference numerals.

The underwater cleaner 1 comprises a suction nozzle housing 3 forming a suction nozzle 2 and including a suction chamber 4. An exhaust channel 5 to which a filter device 6 is connected commences at the suction chamber 4.

The underwater cleaner 1 relies for operation on the water jet pump principle. A water jet nozzle 7, which is connected to an external or an internal pressure source, opens out into the dome-shaped suction chamber 4 in the region of the suction nozzle 2. In the exemplary embodiment, the pressure source is a submersible pump 10 integrated in the suction nozzle housing 3 and having a

pressure socket 9 that is flow connected to the water jet nozzle 7 through a connecting line 8. In the embodiment illustrated in the FIGS. 1 through 3, the suction port 11 of the submersible pump 10 is located outside of the suction nozzle housing 3 in the bottom region of the underwater cleaner 1 in proximity to the suction plane 16 defined by the suction mouth 19, a sieve 12 for retaining coarse impurities being disposed in the region of the intake opening 11. The distance between the intake opening 11 and the suction plane 16 of the underwater cleaner 1 is thereby substantially smaller than the maximum height H of the suction chamber 4. The low location of the intake opening 11 allows utilizing the underwater cleaner 1 in very shallow water.

A strong water jet is fed by the submersible pump 10 supplied with direct current through a battery or an accumulator 13 and through the water jet nozzle 7 into the suction chamber 4 where it creates a negative pressure causing dirty water to be drawn through the suction nozzle 2 and finally to be delivered to the filter device 6. The water passes through the filter device 6 and is then returned to the swimming pool.

The important point is that the water jet nozzle 7 is disposed in closest possible proximity to the suction plane 16. For the performance of the underwater cleaner 1 it has been found to be particularly advantageous if the distance h between the outlet of the water jet nozzle 7 and the suction plane 16 is smaller than half the inner width b of the exhaust channel 5 and for example less than 7 cm, preferably less than 3 cm. This makes it possible to also remove impurities having a heavier mass such as small or medium-sized pebbles 14 from the body 15 to be cleaned, the bottom of a swimming pool for instance, since the pebbles 14 are swept away and toward the exhaust channel 5 by the water jet. Accordingly, the underwater cleaner 1 relies for operation on the combined suction and pressure effect resulting from the water jet entering the suction chamber 4, said water jet being denoted by the arrow S in FIG. 2. Best suction is achieved when, in operation, the suction plane 16 coincides with the plane of the body 15 to be cleaned.

In the region in which it opens out into the suction chamber 4, the water jet nozzle 7 should be slightly inclined upward toward the exhaust channel 5 in order

to make it possible for the impurities to be particularly quickly carried away and into the filter device 6. If the angle α formed between the centreline 7' in the region in which the water jet nozzle 7 opens out into the suction chamber 4 on the one side and the suction plane 16 in the bottom region of the suction nozzle housing 3 extending approximately parallel to the body 15 to be cleaned when the underwater cleaner 1 is in operation on the other side is 45° maximum, preferably 25° maximum and most preferably 15° maximum, so that the water jet denoted by the arrow S in FIG. 2 flows toward the exhaust channel 5, the impurities can be quickly carried away and into the filter device 6.

In order to increase the suction effect of the suction nozzle 2, said suction nozzle 2 is surrounded by rubber lips or brushes 17 forming the suction mouth 19. This permits to achieve outstanding suction effect even if the body 15 is uneven.

The underwater cleaner 1 can be guided over the bottom 15 of a swimming pool by means of a, for example telescopic, actuation rod 18 mounted at a rigid angle to the suction nozzle housing 3. Since the filter device 6 is disposed on the actuation side A turned toward the user, the user has an unhindered view of the body 15 that remains to be cleaned and is located in the direction of travel of the underwater cleaner 1, the user being thus capable of quickly discerning impurities that are to be sucked up and of also utilizing the underwater cleaner 1 in otherwise difficult to access corners or in the region of steps in a swimming pool for example.

The FIGS. 4 through 6 show a second embodiment in which the outlet port 11 of the submersible pump 10 is disposed higher than the pressure socket 9 in a lateral region of the underwater cleaner 1. The submersible pump 10 is thereby fastened via fastening clamps 20 to the suction nozzle housing 3. This allows for very low cost production. The outlet opening 11 located remotely from the suction plane 16 offers the advantage that the water flowing through the submersible pump 10 is quite pure and that it is quite unlikely that the sieve 12 be dislocated.

As can be seen from FIG. 4, the submersible pump 10 is connected to the battery housing 13 through a cable 21 configured to be a spiral channel. The

battery housing 13 is detachably fastened to the actuation rod 18 by rubber bands that have not been illustrated in detail herein. The plug-type connection 22 of the cable 21 to the battery housing 13 is secured against inadvertent release.

The FIGS. 7 through 9 show another embodiment of an underwater cleaner in which the submersible pump 10 and the battery housing 13 are integrated in the suction nozzle housing 3. A connection terminal for a charger plug of the accumulator is indicated at 23. The electrical terminal 23 is sealed against the surrounding water by a screw-down cap for example. Reference numeral 24 designates a sealed region in which electrical parts such as battery housing 13, lines and electrical terminal 23 are sealed against water.

The underwater cleaner 1 can be switched on through a switch, a water sensor or a solenoid switch.

At need, the underwater cleaner 1 may also comprise a special casing, in the shape of an animal for example.

In the underwater cleaner 1, the combined use of suction and pressure for detaching and carrying away the impurities makes it possible to provide the submersible pump 10 with very small dimensions and to design a very compact and light-weighted underwater cleaner 1.

In an alternative embodiment, the water jet nozzle 7 can be connected via the connecting line 8 to an external source of water pressure such as a hose connected to a water line rather than to the submersible pump 10. This may allow the submersible pump 10 and a current source to be eliminated. However, in this embodiment, additional water is introduced into the swimming pool, which is not always desirable.